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Charles Darwin in Australia; or How to Introduce Some Local Colour to the Teaching of Evolution, Geology, Meteorology, and the Determination of Longitude

by

Frank W. Nicholas

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ABSTRACT: the background to Charles Darwin's little-known visit to Australia, and the account of his experiences while here, provide some invaluable historical material for teaching evolution, geology, meteorology and the determination of longitude. Indeed, by using his Australian experiences as a foundation, it is possible to explain the theory of evolution in a much more constructive manner than is usually the case. A day-trip to the Blue Mountains provides the opportunity for students to retrace Darwin's footsteps, and to learn much about geology and the development of Darwin's ideas.

INTRODUCTION

One of the best-kept secrets of Australian history is that Charles Darwin visited these shores in 1836, at the tail end of the round-the-world voyage of H.M.S. *Beagle*.

Why did the *Beagle* come here? Why was Darwin on board? What did he do during his visit? Did he see anything in Australia that might have influenced the development of the theory for which he is now remembered? Did he have any friends in Australia? If so, did he keep in touch with them after his return to England? How did Australians react to the publication of his most famous book, *On the Origin of Species by Means of Natural Selection*[1]?

The aim of this paper is to provide answers to these questions, and, in so doing, to show how a little bit of local history can enhance the teaching of not only that most challenging of topics – the theory of evolution – but also the apparently unrelated scientific topics of meteorology, geology, and the determination of longitude.

BACKGROUND TO THE VOYAGE OF H.M.S. *BEAGLE*

As a major sea-faring power in the 18th and 19th centuries, Britain had great need of accurate charts of the many coastlines around the world that were likely to be frequented by British ships. To achieve this, the Admiralty commissioned many surveying voyages. In 1826, H.M.S. *Beagle* and H.M.S. *Adventure* were sent to survey the southern coastline of South America. In overall command was Captain Phillip Parker King, son of the third Governor of New South Wales (Philip Gidley King, Senior), by then one of the Royal Navy's most senior navigators, having established his reputation during a series of four surveying voyages in Australian waters from 1817 to 1822. (The story of these voyages is told in a most entertaining and informative manner by Hordern, 1997).

The South American survey voyage achieved notable success. However, the often harsh environment took its toll: the commander of the *Beagle*, Captain Pringle Stokes, committed suicide at the southernmost tip of the mainland in August 1828. Both ships returned to Rio de Janiero, where Robert FitzRoy, a 23-year-old lieutenant, was appointed as Stokes' replacement. During the final two years of the surveying voyage, FitzRoy experience the harsh environment of Tierra del Fuego at first hand. He also had altercations with the native Feugians, at one stage taking hostages for the return of a boat they had 'stolen'. Having failed to regain the boat,

but having decided to that some good might come from exposing his captives to English 'civilisation', FitzRoy decided to take the Feugians home with him, and after some education, to return them to their homeland, thereby planting the seeds for British 'civilisation' in yet another corner of the globe. By 1831, FitzRoy was ready to return the natives, and, after the intercession of an influential uncle, FitzRoy was conveniently commissioned by the Hydrographer of the Royal Navy, Captain Francis Beaufort, to complete the survey of South American waters in the *Beagle*. Such were the somewhat unusual circumstances that led to the *Beagle*'s second voyage, the voyage that has now entered history as the voyage of Charles Darwin.

How did Darwin come to be on board? The main reason is that, having experienced the loneliness and isolation of a commander of a small ship in the southernmost regions of South America (and recalling that his predecessor had been driven to suicide), FitzRoy knew that he would benefit greatly if he could have a "gentleman" companion – someone with whom he could share his meals and his worries; someone who would be outside the normal pyramid of command, at the top of which the captain by necessity had to lead a somewhat isolated existence. Since FitzRoy considered himself to be a scientist (he was later to become a Fellow of the Royal Society), and since the voyage was considered to be a scientific one, it made good sense to try to find a scientist who could fill the companion's role. FitzRoy made enquiries to Beaufort, who contacted his Cambridge colleagues, who suggested "Mr. Charles Darwin, grandson of Dr. Darwin the poet, as a young man of promising ability, extremely fond of geology, and indeed all branches of natural history"[2]. After a somewhat checkered education, Darwin's studies had culminated in three years at Christ's College, Cambridge, with the aim of preparing for the ministry. Having passed his final exams, Darwin had to stay in Cambridge for two more terms to satisfy the degree requirements. These he occupied very fully, in effect as a postgraduate student in geology and natural history. As the above quotation shows, he obviously impressed his mentors.

Like many of his contemporaries, the young Darwin was fascinated by natural history. The many glories of nature were seen as a reflection of God's magnificent creative powers, and, as such, there could be nothing more noble and uplifting than to collect and study the specimens of nature. Darwin's particular interest was beetles – he was an avid beetle collector. But, as hinted in the quotation above, Darwin was even more of a geologist at this stage of his life – he was exceedingly interested in landforms.

Well, now we know why Darwin was on board. But why did the *Beagle* come to Australia, if the purpose of the voyage was to complete the surveys of South America? The answer to this question introduces another fascinating story in the history of science.

In the 18th century, one of the greatest unsolved scientific challenges was the estimation of longitude. For centuries, sailors had been able to obtain accurate estimates of latitude simply by measuring with a sextant the height of the sun above the horizon at noon local time, i.e. when the sun was at its zenith (highest point). But the determination of longitude had remained an unsolved problem for far too long. So much so that in 1715, the British Government had offered a reward of up to £20,000 to anyone who could invent a method of determining longitude.

Since the earth revolves once every 24 hours, and since its circumference had been arbitrarily divided into 360 degrees of longitude, it followed that each degree of longitude was equivalent to one 360th of 24 hours, which equals four minutes. Thus, if the sun reached its zenith at one location eight minutes later than at another location, those two locations must be separated by two degrees of longitude. As soon as an arbitrary reference point of zero degrees longitude had been agreed upon (the English chose the Greenwich Observatory), the problem of

letermining longitude became a matter of determining the difference between time at Greenwich and the local time at the place whose longitude was being determined

Soon after the announcement of the reward, it became evident that the most likely way to win it would be to invent a clock (chronometer) that would keep accurate time (Greenwich time) despite being subjected to extreme changes of temperature and atmospheric conditions during long voyages in tossing ships. After a lifetime devoted to the cause, John Harrison, a carpenter from the Lincolnshire village of Barrow, with no formal training in clockmaking, finally won the reward in 1773. Captain Cook was the first to take a chronometer on a long surveying voyage, using a copy by Larcum Kendall of Harrison's fourth instrument with great success during his second and third voyages. Captain Bligh used this same chronometer on the ill-fated voyage of the *Bounty*.

In 1818, the Admiralty began issuing chronometers to its ships, and by the time of the *Beagle*'s first surveying voyage, King was able to take 12 with him on the *Adventure*, and a further three on the *Beagle*. The virtue in taking more than one instrument lay in the fact that not all instruments were equally reliable, and not all could be guaranteed to continue functioning during a long voyage. For the *Beagle*'s second voyage, FitzRoy collected together no fewer than 22 chronometers. With such an unprecedented battery of time-keepers, Beaufort hoped that FitzRoy would be able to resolve the many conflicting longitude determinations that still then existed. To this end, part of Beaufort's instructions to FitzRoy was that after completing the survey of South America, the *Beagle* should circumnavigate the world, in order to obtain an unbroken chain of longitudes, all determined by the one set of chronometers, at as many places as possible. In addition, the *Beagle* was to call in at any port where longitude had been accurately determined by astronomical means (observing the stars), to enable a direct test of the chronometer estimate.

At that time, the Sydney Observatory on Observatory Hill had not been built (it commenced operations in 1858), but there was an observatory in the grounds of what is now called Old Government House at Parramatta. Built by Governor Darling soon after his arrival in the colony in 1825, this observatory has been highly productive, cataloging no fewer than 7,385 stars in its first five years of operation[3]. Depending on the time of year, FitzRoy was also instructed by Beaufort to check the longitude at Hobart and at King George's Sound (Albany, Western Australia). Although neither location had an observatory, estimates of longitude had been obtained from astronomical observations at both sites, and FitzRoy was to check his chronometrical estimates against these reliable estimates.

This, then, was the reason for the *Beagle*'s visit to Australia – nothing to do with biology or evolution, but very relevant to another major scientific development.

There is one more aspect of the instructions issued by Beaufort that merits some attention. Before getting into this, does the name Beaufort ring any bells? With what technology is his name associated today? How about the Beaufort wind scale – the method of recording the strength of the wind that is now the global standard? Yes, the man who issued FitzRoy with his instructions is the same man who invented the Beaufort wind scale. He had actually devised the scale in 1806, but it was not until he became Hydrographer to the Royal Navy in 1829 that he was in a position to have his pet ideas adopted by others. In fact, the very first time that his wind scale was officially used was when FitzRoy commenced his log on the *Beagle* at the start of the voyage in December 1831. Beaufort could not have chosen a more suitable captain to test his scale: FitzRoy was already very interested in meteorology, and in later life he was instrumental in establishing the world's first regular weather-forecasting service – yet another interesting twist to this story (the more one looks, the more one discovers associations and coincidences that can greatly enliven any science lesson).

Not only did Beaufort devise a wind scale, he also developed a weather code by which meteorological observations could be recorded easily in a standard manner.[4] Thanks to Beaufort's instructions, and FitzRoy's dutiful following of them, we have a complete picture of the weather during every day of the *Beagle*'s voyage, including the time spent in Australia.[5]

DARWIN'S BEAGLE EXPERIENCES PRIOR TO REACHING AUSTRALIA

We have already seen how at the start of the *Beagle*'s voyage, Darwin, like his contemporaries, was an enthusiastic student of nature, seeing it as a manifestation of the omnipotent power of God the Creator. It is important to clearly grasp the implications of this – Darwin did not embark on the *Beagle*'s voyage with the aim of coming up with a revolutionary theory that would be a direct challenge to the authority of the Church. On the contrary, he started the voyage imagining that his collections and observations would greatly add to the evidence supporting the wonderful richness of life that had come into being under God's guiding hand, as described in the Book of Genesis.

As expected, Darwin collected specimens of plants and animals whenever he got the chance during the *Beagle*'s time in South America, sending back crate after crate of material for colleagues in London and Cambridge to classify into the neat little boxes of the Linnean binomial system of classification. If there was no box for a particular specimen, then it must be a hitherto unrecorded species. To be involved in the discovery of 'new' species was to be at the centre of the great excitement that characterised natural history at that time. By the time the *Beagle* had reached Australia, Darwin's reputation was already running high back in England, because of the many 'new' species he had discovered in South America.

Unlike his contemporaries, Darwin not only collected specimens, he also asked penetrating questions. Above all, the more he observed, the more he came to realise that species do not fall into neat, separate boxes. On the contrary, there is a continuum of diversity in nature, and any attempt to classify this continuum into a set of discontinuous categories is doomed to failure – nature defies such categorisation. Of course, dogs are demonstrably different from cats, and one would never be in danger of misclassifying one as the other. But the more Darwin looked at groups of similar species, the more he came to realise the futility of the Linnean view of the world. Nowhere was this more evident than on the Galapagos islands in the southern Pacific Ocean, not far from the South American mainland. Here, as has been told so many times, he observed that each island had slightly different versions of what would appear to be the same species, with each version being exquisitely adapted to its local environment.

The full impact of these observations did not dawn on Darwin at the time – indeed, he was amazingly lax in labeling specimens from the different islands, to the extent that when he tried to make sense of his Galapagos collection after returning to London, he found that many of the specimens were so badly recorded as to be almost useless. But by the time he reached Sydney, he had seen enough to cause him to begin to raise doubts about the views he had held at the beginning of the voyage. The seeds of doubt had been sown.

In reading Darwin's account of his visit to Australia, we must remember another important fact, namely that by the time the *Beagle* sailed through The Heads of Port Jackson on 12th January 1836, the voyage was already into its fifth year; and they were still only half way round the world! Not surprisingly, homesickness and a wish to be gone are recurring themes during his time here.

CHARLES DARWIN IN AUSTRALIA

A full account of Darwin's visit to this country, based on new transcriptions of his notebooks and diary, together with excerpts from letters and his published journal, is presented by Nicholas & Nicholas (1989). In this paper, only the bare essentials will be provided.

As was his custom whenever the *Beagle* called in at a port, Darwin took the opportunity to venture inland – "to get a general idea of the country". To this end, he "hired a man & two horses to take me to Bathurst, a village about 120 miles in the interior & the centre of a great Pastoral district". Setting out on 16th January, he travelled along Parramatta Road, lunched at Parramatta, and arrived in the evening at the Governor Bourke Inn, on the banks of the Nepean River, on the site of what is now the Log Cabin Motor Inn. In his diary, Darwin records "the appearance of infertility" and "the arid sterility" (remember this was the middle of summer), the recurring problem of drought ("there is so great a deficiency in rain & running water"), and the distinctive nature of the eucayptus trees, with their bark hanging in "long shreds, which swing about with the wind; & hence the trees look desolate & untidy". Late in the day, he encountered a party of Aborigines who threw their spears for him. In pondering their state and their likely future, Darwin foresaw the effect of the European settlers on these people: they would be increasingly forced into more marginal areas, and when "the difficulty in procuring food is checked of course the population must be repressed" - a distinctly Malthusian remark, which is interesting in view of the fact that he did not read Malthus until two years after writing this passage. For someone of his class and time, Darwin was surprisingly sympathetic to the plight of the Aborigines.

Having crossed the Nepean on a primitive ferry (the Emu Ferry) the next morning, Darwin travelled up what is now Mitchell's Pass, over the new bridge that had been completed less than two years earlier (it was restored in the late 1970s, and was re-opened to traffic in 1982), passed the Pilgrim Inn at the top of the Pass (the remains can be seen in the parking lot of McDonald's at Blaxland), and on to the Weatherboard Inn in what is now a corner of Pitt Park at Wentworth Falls (on the northern side of the highway). In his diary, Darwin records that he had been told that "About a mile & half from this place there is a view, exceedingly well worth visiting".

He was, of course, referring to the view of Jamison Valley from the top of the Wentworth Falls, which even in the 1830s, was a major tourist attraction. Thanks to the sterling efforts of the local council, it is now very easy to walk the same path as Darwin took on that day in January 1836: the Charles Darwin Walk, which starts in Wilson Park, just to the south of the highway, follows in his footsteps. As Darwin describes in his diary, we follow "a little valley & its tiny rill of water" (Jamison Valley Creek), until "suddenly & without any preparation, through the trees, which border the pathway, an immense gulf is seen at the depth of perhaps 1500ft beneath ones feet". The wonderful thing about this dramatic ending to the Charles Darwin Walk is that the scenery hasn't changed in more than 150 years – the view is just the same as it was on that January day in 1836. So, in a very real sense, we can share with Darwin his utter amazement at the valleys of the Blue Mountains: "The class of view was to me quite novel & certainly magnificent".

The geological puzzle of the Blue Mountains

Darwin was intrigued by the valley that stretched before him. How could it have been formed? His diary is full of questions but is short on answers. Darwin the geologist was perplexed. Eight years later, when his account of the geology of Australia was published as Chapter VII of *Volcanic Islands* (Darwin, 1844), he attempted to explain how the valley had been formed. At first he suggested (correctly) that they had been produced by erosion. But on further thought, he could not see how so much stone could have been removed by this process. He therefore turned to an alternative explanation, namely that the valleys had been formed at a time when the whole of what is now the Blue Mountains had been under water, by underwater wave action

– the so-called marine denudation explanation. At this time, Darwin was still at an early stage of appreciating the length of the geological time scale. In later decades, by which time he was much more at home with the idea that geological processes had been continuing for hundreds of millions of years, he abandoned the denudation theory, and returned to the erosion explanation, which is regarded as being correct.

This episode in the history of science illustrates a very important point, namely that famous scientists are not always right. Good scientists are continually questioning, and formulating theories on the basis of their observations. Sometimes their theories will turn out to be correct; sometimes they will be wrong. But it is only by continually questioning and attempting to explain phenomena that knowledge progresses. The mark of a great scientist is that he/she is willing to change their mind in the light of additional information.

We shall now rejoin Darwin on his journey. With the images of the Jamison Valley still swirling in his mind, he walked the 2 km back to the Weatherboard Inn, and rode on to Blackheath, where he stayed at the Scotch Thistle Inn, on the site of what is now Gardner's Inn on the eastern side of the highway, in the middle of the town. Early next morning, he "walked about 3 miles to see Govett's leap, a view of a similar, but even perhaps more stupendous, character". Again, fortunately for us, the view of the Grose Valley is still just the same as when Darwin saw it in 1836. Walking back to Blackheath, Darwin then rode down the newly constructed Victoria Pass ("To effect this pass, an enormous quantity of stone has been cut through, the design, & its manner of execution, would have been worthy of a line of road in England, even that of Holyhead") and continued on to Wallerawang, which was then the homestead of a large sheep station. The actual house in which Darwin stayed survived until 1979, when the area was flooded to create a lake to supply water for the Wallerawang power station.

The ant-lion episode

The next day, Darwin was taken kangaroo hunting by his host, the joint superintendent of the station. Unfortunately, they "did not see a Kangaroo or even a wild dog". However, they did see one of Australia's peculiar animals -- a rat kangaroo (potoroo) about the size of a rabbit. That evening, while resting on the banks of the Cox's River which flowed past the homestead, Darwin had his first and only sighting of a platypus:

"In the dusk of the evening, I took a stroll along a chain of ponds (which in this dry country represents the course of a river) & had the good fortune to see several of the famous Platypus or Ornithorhyncus paradoxicus. They were diving & playing in the water; but very little of their bodies were visible, so that they only appeared like so many water Rats".

The next entry in his diary is probably the best known and most discussed of all the entries that he recorded about Australia:

"Earlier in the evening I had been lying on a sunny bank & was reflecting on the strange character of the Animals of this country as compared to the rest of the World. A Disbeliever in everything beyond his own reason, might exclaim, 'Surely two distinct Creators must have been [at] work; their object however has been the same & certainly in each case the end is complete'.

Whilst thus thinking, I observed the conical pitfall of a Lion-Ant:- a fly fell in & immediately disappeared; then came a large but unwary Ant; His struggles to escape being very violent, the little jets of sand . . . were promptly directed against him.- His fate however was better than that of the poor fly's:- Without doubt this predacious Larva belongs to the same genus, but to a different species from the European one – Now what would the Disbeliever say to this? Would any two workmen ever hit on so beautiful, so simple & yet so artificial a contrivance? I cannot think so.- The one hand has worked over the whole world.- A Geologist perhaps would suggest, that the periods of Creation have been distinct & remote, the one from the other; That the Creator rested in his labor."

When interpreting this so-called ant-lion passage, we must remember that in the last few hours, Darwin had seen Australian birds that resembled English birds of the same name (crows, magpies), but which obviously belonged to different species; he had seen a miniature kangaroo the size of a European rabbit, behaving somewhat like a rabbit, darting about in the undergrowth; he had seen several platypuses, which in movement and behaviour might easily have been mistaken for European water rats, even though they were built to a completely different plan; and he had seen an ant lion (actually the larva of a lacewing) using the same extraordinary contrivance as its cousins in the northern hemisphere, but with a pit only half the size of the European one.

So it was that in the space of just a few hours in the middle of January 1836, on an isolated sheep station in inland Australia, Darwin had been confronted with four clear illustrations of the fact that similar environments in completely different parts of the world seemd to be inhabited by animals having similar adaptations, but obviously belonging to different species. In the two most striking cases, the similarly adapted animals belonged to different genera, families, orders and subclasses as well.

To modern biologists, this phenomenon is called convergent evolution, and is seen as evidence of the power of natural selection as an adaptive force. To Darwin it was a puzzle.

Of course, Darwin was not the first European to notice the resemblance in adaptation between Australian and European animals. But he was sufficiently inquisitive to really think about the reason for the resemblance; why would a creator bother to create two animals such as the rat kangaroo and the rabbit, or the platypus and the water rat, which are so markedly different in basic design and in the way in which they bear and raise their young, but which occupy similar environments in two different parts of the world? Why would a creator create two slightly different variants of the same extraordinary ant lion?

If by the "one hand" Darwin means the universal force of natural selection, then the ant-lion passage is one of the earliest glimpses we have, if not *the* earliest glimpse, of the theory that he was to use much later to explain the mechanism of evolution. Alternatively, however, it is quite possible to interpret the "one hand" as referring to God the Creator who "hit on" the one "artificial . . . contrivance" and used it on a different scale in the two different hemispheres of the world. In writing for a very mixed audience (his family back home), Darwin chose words that would offend no-one.

The final sentence is also ambiguous. In a very tentative fashion, it raises the possibility that a geologist (Darwin in another disguise?) might suggest that a single hand worked at "distinct & remote" periods. Containing words like "the Creator" and "periods of Creation", the sentence has a distinctly biblical character; from a certain perspective, it could be readily interpreted in a non-controversial manner by his family and friends back in England. It is also possible, however, to interpret this sentence as a rather subtle attempt to introduce a far-reaching and revolutionary idea: that under the single guiding hand of natural forces, different species have been "created" at different times during the geological time span, in response to the environmental conditions prevailing at any particular time and place. Once again, it appears that Darwin has chosen his words carefully.

When preparing his diary for publication as *Journal of Researches*, Darwin made some editorial changes to the above passage, improving the English and clarifying a few points. By 1845, when the time came for a second edition of the *Journal* to be published, Darwin's ideas on evolution were much more fully developed. Indeed, most of the important elements of his evolutionary theory had already been committed to paper (but not to print) in his "abstract" of 1842 and his longer, 230-page "sketch" of 1844. Despite this, Darwin was still very reticent. In

the Australian section of the 1845 *Journal*, all of the speculative sentences previously in the ant-lion passage have been omitted, and the remaining descriptive sentences have been relegated to a footnote.

At first thought, it is difficult to know what to make of this. Was it because he was now so certain about his ideas, that speculative sentences were no longer necessary? Had he progressed beyond the stage of asking questions? If so, then why didn't he replace the questions with the answers? Why just simply remove the questions?

Perhaps he felt that this was neither the time nor the place for providing the answers. He was, after all, still meticulously compiling example after example to support the answers that were by now well formed in his own mind; and many more examples were to be collected during the next thirteen years before he was finally coaxed into putting his principal ideas into print. Even then, he still felt that he was not ready. Moreover, the *Journal* was primarily a travelogue, and a very successful one at that: it remained a popular book well into the present century, and was translated into 23 other languages.

It seems safe to conclude, therefore, that the speculative sentences in the ant-lion passage were victims of the condensation and downplaying of scientific aspects of the voyage that occurred during the preparation of the 1845 edition. It was no longer satisfactory to simply ask the questions: he had certainly advanced beyond that stage. And yet to have provided appropriate answers would have required an expansion rather than a condensation of the scientific content. It would be best simply to remove the questions and save the answers until he had collected more examples, and was ready to publish his fully fleshed ideas in a proper scientific manner.

The rest of the Bathurst trip, and the return to Sydney

We need not dwell too long on the rest of this trip – whilst it is very interesting from an historical perspective, there is relatively little science. The day after the ant-lion episode, Darwin rode overland to Bathurst, following more or less the line of the modern highway. He and was very unimpressed with the young inland village. He then returned to Sydney along what was then the only Bathurst road, which can still be followed through O'Connell, Tarana, and Sodwalls, rejoining his previous route at Old Bowenfels, just south of modern Lithgow. On the way back over the Blue Mountains, he fell sick, and spent several days resting in the Weatherboard Inn after having walked again down the Jamison Valley Creek to see the magnificent view.

After descending to the plains and crossing the Nepean River, he visited Captain King – the same King who had commanded the *Beagle*'s first surveying voyage. After farewelling the *Beagle* on its second voyage, King had returned to Sydney, and had taking up farming on a property called Dunheved, on South Creek. The house in which Darwin stayed the night was located on the eastern bank of the creek, just north of the present-day Dunheved golf course. Darwin records that he "spent a very pleasant afternoon walking about the farm & talking over the Natural History of T. del Fuego". At this time, King was busy preparing his account of the *Beagle*'s first surveying voyage. King had been an enthusiastic collector and observer of natural history during that voyage, and reprints of a paper describing his collection of barnacles and molluscs had just arrived in the colony. King enscribed a reprint and gave it to Darwin. The next day, King took Darwin to lunch at Vineyard, a beautiful mansion recently built by Hannibal Macarthur (King's brother-in-law) on the northern bank of the Parramatta River at modern-day Rydalmere, and by evening, Darwin was back on board the *Beagle* in Sydney Harbour.

In the few days remaining before the *Beagle* sailed, Darwin collected shells and insects around the harbour. Among the former, he gathered a mudwhelk, several air breathers, a sand snail and a trochid or top shell. His servant Syms Covington[7] had already been out collecting, during Darwin's trip to Bathurst. Between the two of them, they gathered 92 different species of insects representing five different orders.

Although Darwin was a keen entomologist, he was not expert at identification, and left this task to others to whom he gave his insect collection once he had returned to England. In time, many scientific papers were written by his colleagues describing the insects collected throughout the voyage. These papers show that of the 92 species collected in Sydney, 31 were previously unknown. Included among these new species were a leaf beetle (*Foenus darwinii*) and a bee (*Halictus darwiniwllus*) that were each named after Darwin. The remainder consisted of 20 new parasitic wasps, five new flea beetles, one new weevil and one new leafhopper.

Hobart and King George's Sound

The *Beagle* left Sydney on 30th January, and arrived in Hobart 6 days later. Darwin had great fun in Hobart, celebrating his 27th birthday on 12th January, and doing lots of geologising and naturalising with the young and enthusiastic Surveyor-General George Frankland. A Hobart geologist, Dr Max Banks, has made a detailed study of Darwin's geologising during his Hobart sojourn, and his two papers on the subject make fascinating reading, enabling us to retrace Darwin's footsteps very accurately[8]. However, because these sites are not readily available to the present audience, we will not go into detail here. Suffice to note in passing that Darwin continued to be on the lookout for items of interest – he collected several fossil shells (two of which were later classified as new species), an oak skink, five other lizards including a blue-tongue, a snake (either a black tiger snake or a copperhead, both of which are venomous, and which could easily have harmed Darwin, who thought it was non-venomous), some planaria (flatworms) on which he performed experiments on board the *Beagle*, shells (including rock barnacles, a bivalve, a whelk, an amber shell, bulimoid land shells, periwinkles, top shells and air breathers), and insects (at least 199 species, 63 of which were later shown to be new, including dung beetles, leaf beetles, ladybird beetles, weevils, ptinid beetles, parasitic wasps, a water scavanger beetle, a spider beetle and a bee). Quite a remarkable collection.

By 6th March, the *Beagle* was anchored in Princess Royal Harbour, off present-day Albany. Compared with Hobart and Sydney, this was an isolated, desolate settlement, and Darwin was not very impressed. He did, however, witness a corroboree, and, once again, gathered some natural history specimens. This time his bag included a previously unknown species of native Australian rodent: the bush rat, *Rattus fuscipes*, which he "caught in a trap baited with cheese, amongst the bushes at King George Sound". This animal is unusual in that it is not a marsupial, but it is a native of Australia. He also collected a southern frog, at least 10 different fish (of which four turned out to be new species), a variety of shells (including barbacles, an air-breating limpet, a nerite, a littorinid, a periwinkle, a *Physa* from a fresh-water lake, and several bulimoid land snails), and many insects (at least 66 species, including 48 not previously recorded; six of which were named after their discoverer – two planthoppers [*Haplodelphax darwinii* and *Alleloplasis darwinii*], a small-headed fly [*Ogcodes darwini*], a seed bug [*Ontiscus darwini*] and a parasitic wasp [*Anipo darwini*]).

THE YEARS THAT FOLLOWED

Soon after leaving Australia, Darwin started recording notes that indicate his ideas where already undergoing substantial changes. And it certainly does seem that his observations in Australia (and especially on that sunny day at Wallerawang) did play some role in the evolution of his ideas.

As we have noted previously, it was not that he set out to develop a theory that would challenge the authority of the Bible. On the contrary, he set out to observe and document God's world. But these very observations forced him to abandon the idea of species as fixed entities – the natural world just did not fit with this concept. Of course, Darwin was not the first person to have suggested that species had evolved. Indeed, his very own Grandfather, Erasmus Darwin (the "poet" mentioned earlier in this article) and other scientists had long argued that life had evolved. But neither Darwin's grandfather nor any of the other early evolutionists had been able to suggest a plausible mechanism. This was Darwin's great contribution - faced with the fact that species were not fixed, Darwin set out to devise an explanation; certainly not a perfect one, but a far better explanation than anything available then or since. As we have seen earlier, by 1842 he had committed to paper the main thrust of his argument – that evolution had occurred by means of natural selection. Two years later, this was expanded to his larger 'sketch'. But still he needed more evidence to support his arguments.

As is well known, Darwin would have delayed publication of his ideas for much longer had it not been for the unexpected arrival in 1858 of a paper from Alfred Wallace, who had independently hit upon the same idea as Darwin[9]. After some drama, an honourable solution to the problem of precedence was reached by Darwin's colleagues, who arranged for a joint publication of Wallace's paper and several documents that clearly showed Darwin's long-held views. Suitably chastened, Darwin got to work on a summary of his ideas and the evidence, which was published as *On the Origin of Species by Means of Natural Selection* in 1859.

What was the reaction to *Origin* in Australia? As elsewhere, there was considerable consternation in some quarters, and especially in the Church. However, one notable exception, and possible the only man of the cloth to write to Darwin, praising the book, was the Reverend W.B. Clarke, the pioneering geologist and the then incumbent of the parish of St Thomas at North Sydney. Darwin responded to Clarke in a letter written in October 1861. Included in this letter was a request for Clarke to pass on Darwin's best wishes to "my old ship-mate Mr [Conrad] Martens", who had been the artist on board the *Beagle* for a year or so during the South American phase of its voyage, and who was then one of Clarke's leading parishioners. This is just one of the many coincidences that occur in the story of Darwin's association with Australia.

Martens' responded to Darwin in a letter written in January 1862. In it, he sums up his own feelings about the controversial book – feelings that were probably quite widely held:

"Your 'book of the season' as the reviewers have it, I must own I have not yet read, altho Mr Clarke offered to lend it me. I am afraid of your eloquence, and I don't want to think I have an origin with toads and tadpoles . . .".

This, of course, was one of the major challenges of Darwin's book – it pushed humans off their unique pedestal as God's special creation; it reduced them to just another species, and it suggested that all species had arisen from natural processes over exceedingly long periods of time. In one blow, it removed much of God's raison d'etre.

In addition, the more one accepted a literal reading of the Bible, the greater was the apparent conflict between what was said in Genesis and what Darwin said.

In the 140 years since the publication of *Origin*, the issue has not been settled. There are still many people who, when faced with a choice between the bible and Darwin, chose the bible. Anyone who attempts to teach evolution must come to terms with this reality.

TEACHING EVOLUTION TODAY

How, then, should we approach the task of teaching evolution? The answer is: with humility. Unfortunately, much of modern popular evolutionary writing is written in exactly the opposite mold – natural selection is expounded with a religious fervour that is amazing to behold, and with a naivety that plays right into the hands of those who take great delight in opposing the idea.

The most sensible approach is to start by carefully explaining the history of the development of Darwin's ideas. And, as outlined in this article, if this is being done in Australia, teachers have some wonderful local historical stories to help with the explanation. Quite quickly and painlessly, you will have reached the point where it is evident that the biological facts that can now be observed are at variance with a literal interpretation of the bible. Thus the bible can't be literally true. Like all books, it is a product of its time; quite possibly divinely inspired, but nevertheless a product of its time. Consequently, we should not be surprised to discover, as Darwin did, that the sections of the bible that describe the origin of species provide an inadequate explanation of the facts that can now be observed, but which were not even imagined at the time the books of the bible were being written. To take just one example, marsupials and monotremes were unknown when the bible was written. Thus the questions posed by Darwin on the banks of the Cox's River at Wallerawang were outwith the realms of human knowedge in biblical times.

In short, the bible was never written to serve as a biology textbook for the late 20th century.

It can, however, still serve as an extremely valuable spiritual guide. This, after all, is by far the most important aspect of religious belief, and it is the area in which God still has a very real raison d'etre.

The reason for so much of the conflict between religion and evolution is that historically, religious leaders have tended to invoke God as the explanation for all things that were otherwise inexplicable at the time. For many centuries, and especially amongst illiterate congregations, this worked very well. Indeed, it strengthened the position of organised religion, and it helped to keep people from straying too far from the narrow path – if God is in charge of everything, then he is bound to know exactly all of the sins you have committed, and will punish you accordingly. But as knowledge expanded, and as congregations became more educated, inevitably this view of God was going to be threatened. If religious leaders had confined themselves to God as love; if they had emphasised the enormous benefits that so many people gain from a belief in a spiritual power that stands apart from all the trials and tribulations of daily existence; as an entity with whom one can communicate in times of need; then Darwin's ideas would have posed no threat to organised religion. Indeed, the reason why so many of today's Christians are perfectly happy with the idea of evolution is that they have this latter idea of God: their faith in things spiritual does not rely on the existence of a God who is concerned with what sort of creature should live on the banks of the Cox's River at Wallerawang.

Finally, when discussing the theory of evolution, it is essential to emphasis that in attempting to provide an explanation that is more consistent with the observable facts than a literal interpretation of the bible, Darwin never once thought, let alone claimed, that his was a perfect theory. Indeed, the *Origin* is touchingly full of doubts and apparent problems with the theory. There is even a whole chapter entitled 'Difficulties of the Theory'. This is not the work of someone who thought he had all the answers!

People who attack the idea of evolution, and particularly so-called creation scientists, usually fail to appreciate this important point. They eagerly latch onto any weakness in the theory, believing that if they can show that one element of the idea provides a less than perfect explanation of observable facts, then the whole theory must be false, and, what's more, the biblical account of creation must be correct! It is to be hoped that few people would be taken in by this 'logic'.

The thing to do in response to such claims is to freely acknowledge that the theory is still far from perfect, but that it is a far better explanation than anything else that has so far been put forward, If, at some time in the future, an even better explanation comes forward, then that is fine. If Darwin were still alive, he would greet such a development with great enthusiasm

SOME VALUABLE RESOURCES

Apart from those resources already mentioned, there are several others about which readers should be aware.

The first is a slim volume containing a selection of the most important of the more than 14,000 letters that were written by or to Darwin[10]. This provides a marvellous first-hand introduction to the life and times of Darwin. The next thing that one should read is the first edition of *Origin*. If your only previous experience and knowledge of Darwinism has come from secondary sources, these two books will be a revelation to you – they show a very different Darwin from the person often portrayed in modern popular literature.

Finally, in this age of the personal computer with a CD-ROM drive, readers will be interested to know that almost the works of Darwin can be purchased on a single CD-ROM (Ghiselin & Goldie, 1997). There are one or two books missing, but just about all of the important documents are there, in an easy-to-read format. It even includes the Wallace and Darwin papers that were read at the Linnean Society in 1858. Unfortunately, the version of *Origin* that is included on the CD-ROM is the last (6th) edition, which has more imperfections that the first edition (In responding to his critics, Darwin often made matters worse). However, this is a minor blemish on what is a very useful resource.

A DARWIN DAY-TRIP TO THE BLUE MOUNTAINS

Suitably prepared by the advance reading described above, teachers can then plan a Darwin day-trip to the Blue Mountains, retracing his steps. In addition to a copy of Nicholas & Nicholas (1989) (which is now unfortunately out of print; but which is still available from many public libraries), you should also obtain a copy of the booklet by Pickett & Alder (1997) which has been especially written to provide a lay person's introduction to the geology of the Blue Mountains. Armed with these two books, and with the background provided by reading the two books mentioned above, you will be able to bring geology and evolution alive to your students in a way that you (and they) never imagined was possible.

NOTE

In preparing this paper, I have made free use of text in Nicholas & Nicholas (1989).

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[1] For the full bibliographical details, see the entry for Darwin (1859) in the references.
[2] All quotations are taken from transcriptions from contemporary documents, reproduced by Nicholas and Nicholas (1989), who provide full bibliographic details. This particular quotation is on page 5 of Nicholas & Nicholas (1989).
[3] see Richardson (1835).
[4] The original published versions of the Beaufort wind scale and weather code are reproduced in Nicholas & Nicholas (1989, p. 4).
[5] An example is reproduced on page 5 of Nicholas & Nicholas (1989).
[6] This is the first (1839) edition; for full bibliographic details, see Nicholas & Nicholas (1989), p. xi.
[7] The subject of a recent historical novel by McDonald (1998).
[8] See Banks (1971) and Banks (1998).
[9] For a recent book on Wallace, see van Oosterzee (1997).
[10] See Burkhardt (1996).